SCIENCE

A WEEKLY RECORD OF SCIENTIFIC PROGRESS.

ILLUSTRATED.

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JOHN MICHELS, Editor.

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INSANITY VERSUS CIVILIZATION.

It is interesting to note the steady progress made by Alienists in solving the many difficult problems which appear to underlie the practice of their profession, and we would give full credit to those who, in a purely scientific spirit, are building a foundation on which a system of treatment for mental diseases may be erected, which shall accord with modern anatomical discovery and the latest theories which have been developed by a careful study of insanity in all its forms.

The last number of the "*Journal of Nervous and Mental Diseases*" may be studied with advantage by those who would gather a few opinions expressed by those who "minister to a mind diseased." In the first place, we have the authority of Dr. J. S. Jewell for stating that insanity is on the increase, and must still increase with the advance of civilization. In this opinion he is confirmed by Professor W. Erb, of Leipzig, and others. Among the reasons advanced for alleging that the advance of civilization is favorable to an increase in nervous and mental diseases, it is stated, that the nervous systems of highly cultivated and refined individuals among civilized people are more complex and refined in structure and more delicate in susceptibility and action, at least in their higher parts, than the nervous systems of savages. As civilization advances, the occupations increase which imply a cultivation of the sensibilities, more especially those comprehended under the sense of beauty. A relatively large number of persons give themselves to the study and practice of art in its various forms, to polite literature, and to sedentary occupations. The more a part of the nervous system is used the more extended its development. In highly civilized communities there is a constant tendency to a loss of balance in nerve development, in which the *sensitive* side of the nervous system preponderates over the motor part of the same. Now, all disturbances of symmetry or balance in development tend toward disease; they do not constitute disease, but verge in that direction. This state of things is the result of advancing civilization, and involve a world of minor consequences, both for the weal and woe of the people.

Such is the substance of Dr. Jewell's views, who also charges the system of education in public schools with being the cause of increasing the number of cases of insanity, by breaking up the "*nerve health*" of youths. This remark applies equally to the course of study in Colleges and Universities, and the overworked student in hundreds of cases obtains his degree at the expense of loss of health, and retires with general nervous and brain exhaustion, and afflicted with melancholia, hysteria, vascular irregularities, cerebral congestion, neuralgias and other disorders of the same character.

Space will not permit us to describe the many forms in which the adult, in civilized life, courts the approach of the various forms of insanity; but they can be easily surmised, and are often referred to in articles treating on this subject.

We admit, with Dr. Jewell, that the higher developments of civilized life may produce a higher strain on the nervous system which may lead to more frequent cases of its derangement; but we think he draws too wide a parallel when he makes a distinction between our present modes of existence and actual savage life. When speaking of the increase of insanity, it is presumed reference is made to a period covering, perhaps, the last fifty years. Such being the case, we think Dr. Jewell has hardly done justice to the subject, by omitting the many mitigating circumstances attending an advanced civilization, which certainly alleviate many of the mental strains spoken of by him.

Within the last fifty years, the hours of labor have been curtailed both in manufactories and among the industrial classes in cities. Stores which at one time were open until midnight are now closed at 7 P. M. Means of recreation and amusements which until recently were monopolized by a few, are now enjoyed by the millions. Improved methods of transit now enable citizens to enjoy their evenings after the hours of labor, strolling upon grassy meadows or upon the shores of the ocean. Literature of an entertaining character is also now produced so cheaply as to make its use universal. The laws of hygiene are also at this present day better understood, and, by perfecting man's physical condition, instill fresh energy into his mental powers.

We thus find that, so far from all the conditions attending an advanced civilization being favorable to

insanity, many have a tendency to promote the most perfect mental and physical development.

If the Alienist would solve the problem attending the increase of cases of insanity, we would direct him to other sources of the evil than that of civilization; let him probe the open and hidden vices of great cities; let him calculate the effect of the indiscriminate use of alcoholic liquors and the pernicious abuse of potent drugs. We regard opium, tobacco, chloral and sewer gas as some of the offending agents which weaken and debilitate the mental powers, rather than the mild educational cause of our public schools or the attending circumstances of student-life.

Dr. Jewell himself admits the destructive effects of these agents upon the nervous system, but they are classed as due to the influence of civilization. This we think an error, as they are connected with vices of a debased life; and although insanity may be on the increase, we consider it is far from conclusive that to civilization we should attribute the primary cause.

SCIENTIFIC SOCIETIES IN WASHINGTON, D. C.

THE BIOLOGICAL SOCIETY.—Three papers were read at the last meeting, Friday, Feb. 25, as follows: A Description of Pronuba yuccasella, by Prof. C. V. Riley; The Hall Collection of Fossils from New York, by Prof. C. A. White; and Suctorial Prehension in the Animal Kingdom, by Mr. Smiley. Professor Riley's paper was a revision of his communications before the American Association at St. Louis and in other places, concerning a moth, the *Pronuba yuccasella*, which not only deposits its eggs in the capsules of the Yucca, but which is also indispensable to the fertilization of the ovaries of that plant. It was remarked by Mr. Lester F. Ward, in commenting upon the paper, that we have here the most wonderful example of commensualism. Professor White is in charge of the duplicate set from the Hall Collection of Fossils sent to the National Museum. His remarks were a brief description of them as they now appear. There are about 1500 entries, and they represent nearly all the types in the Collection of the American Museum. Mr. Smiley's paper was a description of suctorial organs in the various divisions of the animal kingdom. These organs have in different circumstances, three functions, locomotion, anchoring and the seizure of prey. The author has bestowed a great deal of care on his communication and brought together a valuable mass of material.

THE ANTHROPOLOGICAL SOCIETY.—The Society met in the main hall of the National Medical College, Major J. W. Powell in the chair. The following papers were read: Amphibious Aborigines of Alaska, by Ivan Petroff; The Evolution of Marriage Ceremonies and Their Import, by Dr. A. F. A. King. Mr. Petroff described his experience among the shore Innuit population of Alaska, from the lower peninsula north to the Yukon mouth. There is water and marsh, mud and swamp everywhere, and the heavens swell the mass by their contribution of fog, rain, snow and sleet. The natives are enveloped in this watery environment the year round and thrive upon it. They even drink enormous quantities of it, not excepting the salt water of the bays and fiords, in their long fishing journeys, Doctor King's paper was an argument to prove that the progress of civilization had the tendency to set aside the laws of sexual relations which exist in a state of nature, such as the survival of the fittest, the observance of natural periods, and sexual selection. The paper was discusssed by Major Powell and Mr. Ward.

ACTION OF AN INTERMITTENT BEAM OF RADIANT HEAT UPON GASEOUS MATTER.*

BY JOHN TYNDALL, F. R. S.

The Royal Society has already done me the honor of publishing a long series of memoirs on the interaction of radiant heat and gaseous matter. These memoirs did not escape criticism. Distinguished men, among whom the late Professor Magnus and the late Professor Buff may be more specially mentioned, examined my experiments, and arrived at results different from mine. Living workers of merit have also taken up the question; the latest of whom,† while justly recognizing the extreme difficulty of the subject, and while verifying, so far as their experiments reach, what I had published regarding dry gases, find me to have fallen into what they consider grave errors in my treatment of vapors.

None of these investigators appear to me to have realized the true strength of my position in its relation to the objects I had in view. Occupied for the most part with details, they have failed to recognize the stringency of my work as a whole, and have not taken into account the independent support rendered by the various parts of the investigation to each other. They thus ignore verifications, both general and special, which are to me of conclusive force. Nevertheless, thinking it due to them and me to submit the questions at issue to a fresh examination, I resumed, some time ago the threads of the inquiry. The results shall, in due time, be communicated to the Royal Society; but meanwhile, I would ask permission to bring to the notice of the Fellows a novel mode of testing the relations of radiant heat to gaseous matter, whereby singularly instructive effects have been obtained.

After working for some time with the thermopile and galvanometer, it occurred to me several weeks ago that the results thus obtained might be checked by a more direct and simple form of experiment. Placing the gases and vapors in diathermanous bulbs, and exposing the bulbs to the action of radiant heat, the heat absorbed by different gases and vapors ought, I considered, to be rendered evident by ordinary expansion. I devised an apparatus with a view of testing this idea. But, at this point, and before my proposed gas thermometer was constructed, I became acquainted with the ingenious and original experiments of Mr. Graham Bell, wherein musical sounds are obtained through the action of an intermittent beam of light upon solid bodies.

From the first, I entertained the opinion that these singular sounds were caused by rapid changes of temperature, producing corresponding changes of shape and volume in the bodies impinged upon by the beam. But if this be the case, and if gases and vapors really absorb radiant heat, they ought to produce sounds more intense than those obtainable from solids. I pictured every stroke of the beam responded to by a sudden expansion of the absorbent gas, and concluded that when the pulses thus excited followed each other with sufficient rapidity, a musical note must be the result. It seemed plain, moreover, that by this new method many of my previous results might be brought to an independent test. Highly diathermanous bodies, I reasoned, would produce faint sounds; while highly athermanous bodies would produce loud sounds; the strength of the sound being, in a sense, a measure of the absorption. The first experiment made, with a view of testing this idea, was executed in the presence of Mr. Graham Bell;‡ and the result was in exact accordance with what I had foreseen.

The inquiry has been recently extended so as to em-

*Proceedings of the Royal Society.

† MM. Lecher and Pernter, "Philosophical Magazine," January, 1881. "Sitzb. der K. Akad. der Wissensch. in Wien," July, 1880.

‡On the 29th of November: see "Journal of the Society of Telegraph Engineers," December 8, 1880.

brace most of the gases and vapors employed in my former researches. My first source of rays was a Siemens' lamp connected with a dynamo-machine, worked by a gas engine. A glass lens was used to concentrate the rays, and afterwards two lenses. By the first the rays were rendered parallel, while the second caused them to converge to a point about seven inches distant from the lens. A circle of sheet zinc provided first with radial slits and afterwards with teeth and interspaces, cut through it, was mounted vertically on a whirling table, and caused to rotate rapidly across the beam near the focus. The passage of the slits produced the desired intermittence,* while a flask containing the gas or vapor to be examined received the shocks of the beam immediately behind the rotating disc. From the flask a tube of india-rubber, ending in a tapering one of ivory or box wood, led to the ear, which was thus rendered keenly sensitive to any sound generated within the flask. Compared with the beautiful apparatus of Mr. Graham Bell, the arrangement here described is rude; it is, however, effective.

With this arrangement the number of sounding gases and vapors was rapidly increased. But I was soon made aware that the glass lenses withdrew from the beam its effectual rays. The silvered mirrors employed in my previous researches were therefore invoked; and with them, acting sometimes singly and sometimes as conjugate mirrors, the curious and striking results which I have now the honor to submit to society were obtained.

Sulphuric ether, formic ether, and acetic ether being placed in bulbous flasks,† their vapors were soon diffused in the air above the liquid. On placing these flasks, whose bottoms only were covered by the liquid, behind the rotating disc, so that the intermittent beam passed through the vapor, loud musical tones were in each case obtained. These are known to be the most highly absorbent vapors which my experiments revealed. Chloroform and bisulphide of carbon, on the other hand, are known to be the least absorbent, the latter standing near the head of diathermanous vapors. The sounds extracted from these two substances were usually weak and sometimes barely audible, being more feeble with the bisulphide than with the chloroform. With regard to the vapors of amylene, iodide of ethyl, iodide of methyl and benzol, other things being equal, their power to produce musical tones appeared to be accurately expressed by their ability to absorb radiant heat.

It is the vapor, and not the liquid, that is effective in producing the sounds. Taking, for example, the bottles in which my volatile substances are habitually kept, I permitted the intermittent beam to impinge upon the liquid in each of them. No sound was in any case produced, while the moment the vapor-laden space above an active liquid was traversed by the beam, musical tones made themselves audible.

A rock-salt cell filled entirely with a volatile liquid, and subjected to the intermittent beam, produced no sound. This cell was circular and closed at the top. Once, while operating with a highly athermanous substance, a distinct musical note was heard. On examining the cell, however, a small bubble was found at its top. The bubble was less than a quarter of an inch in diameter, but still sufficient to produce audible sounds. When the cell was completely filled, the sounds disappeared.

It is hardly necessary to state that the pitch of the note obtained in each case is determined by the velocity of rotation. It is the same as that produced by blowing against the rotating disc and allowing its slits to act like the perforations of a syren.

Thus, as regards vapors, prevision has been justified by experiment. I now turn to gases. A small flask, after having been heated in the spirit lamp so as to detach all moisture from its sides, was carefully filled with dried air. Placed in the intermittent beam it yielded a musical note, but so feeble as to be heard only with attention. Dry oxygen and hydrogen behaved like dry air. This agrees with my former experiments, which assigned a hardly sensible absorption to these gases. When the dry air was displaced by carbonic acid, the sound was far louder than that obtained from any of the elementary gases. When the carbonic acid was displaced by nitrous oxide, the sound was much more forcible still, and when the nitrous oxide was displaced by olefiant gas, it gave birth to a musical note which, when the beam was in good condition, and the bulb well chosen, seemed as loud as that of an ordinary organ pipe.* We have here the exact order in which my former experiments proved these gases to stand as absorbers of radiant heat. The amount of the absorpti n and the intensity of the sound go hand in hand.

A soap bubble blown with nitrous oxide, or olefiant gas, and exposed to the intermittent beam produced no sound, no matter how its size might be varied. The pulses obviously expended themselves upon the flexible envelope, which transferred them to the air outside.

But a film thus impressionable to impulses on its interior surface, must prove at least equally sensible to sonorous waves impinging on it from without. Hence, I inferred, the eminent suitability of soap bubbles for sound lenses. Placing a "sensitive flame" some feet distant from a small sounding reed, the pressure was so arranged that the flame burnt tranquilly. A bubble of nitrous oxide (sp. gr. 1·527) was then blown, and placed in front of the reed. The flame immediately fell and roared, and continued agitated as long as the lens remained in position. A pendulous motion could be imparted to the bubble, so as to cause it to pass to and fro in front of the reed. The flame responded, by alternately roaring and becoming tranquil, to every swing of the bubble. Nitrous oxide is far better for this experiment than carbonic acid, which speedily ruins its envelope.

The pressure was altered so as to throw the flame, when the reed sounded, into violent agitation. A bubble blown with hydrogen (sp. gr. 0·069) being placed in front of the reed, the flame was immediately stilled. The ear answers instead of the flame.

In 1839, I proved gaseous ammonia to be extremely impervious to radiant heat. My interest in its deportment when subjected to this novel test was therefore great. Placing a small quantity of liquid ammonia in one of the flasks, and warming the liquid slightly, the intermittent beam was sent through the space above the liquid. A loud musical note was immediately produced. By the proper application of heat to a liquid the sounds may be always intensified. The ordinary temperature, however, suffices in all the cases thus far referred to.

In this relation the vapor of water was that which interested me most, and as I could not hope that at ordinary temperatures it existed in sufficient amount to produce audible tones, I heated a small quantity of water in a flask almost up to its boiling-point. Placed in the intermitten beam, I heard—I avow with delight

* When the disc rotates the individual slits disappear, forming a hazy zone through which objects are visible. Throwing by the clean hand, or better still by white paper, the beam back upon the disc, it appears to stand still, the slips forming so many dark rectangles. The reason is obvious, but the experiment is a very beautiful one.

I may add that when I stand with open eyes in the flashing beam, at a definite velocity of recurrence, subjective colors of extraordinary gorgeousness are produced. With slower or quicker rates of rotation the colors disappear. The flashes also produce a giddiness, sometimes intense enough to cause me to grasp the table to keep myself erect.

† I have employed flasks measuring from 8 inches to ¾ths of an inch in diameter. The smallest flask, which had a stem with a bore of about ⅛th of an inch in diameter, yielded better effects than the largest. Flasks from 2 to 3 inches in diameter yield good results. Ordinary test-tubes also answer well.

* With conjugate mirrors the sounds with olefiant gas are readily obtained at a distance of twenty yards from the lamp. I hope to be able to make a candle flame effective in these experiments.

—a powerful musical sound produced by the aqueous vapor.

Small wreaths of haze, produced by the partial condensation of the vapor in the upper and cooler air of the flask, were, however, visible in this experiment; and it was necessary to prove that this haze was not the cause of the sound. The flask was, therefore, heated by a spirit-flame beyond the temperature of boiling water. The closest scrutiny by a condensed beam of light then revealed no trace of cloudiness above the liquid. From the perfectly invisible vapor, however, the musical sound issued, if anything, more forcible than before. I placed the flask in cold water until its temperature was reduced from about 90° to 10° C., fully expecting that the sound would vanish at this temperature; but not withstanding the tenuity of the vapor, the sound extracted from it was not only distinct but loud.

Three empty flasks, filled with ordinary air, were placed in a freezing mixture for a quarter of an hour. On being rapidly transferred to the intermittent beam, sounds much louder than those obtainable from dry air were produced.

Warming these flasks in the flame of a spirit-lamp until all visible humidity has been removed, and afterwards urging dried air through them, on being placed in the intermittent beam the sotum in each case was found to have fallen almost to silence.

Sending, by means of a glass tube, a puff of breath from the lungs into a dried flask, the power of emitting sound was immediately restored.

When, instead of breathing into a dry flask, the common air of the laboratory was urged through it, the sounds became immediately intensified. I was by no means prepared for the extraordinary delicacy of this new method of testing the athermancy and diathermancy of gases and vapors, and it cannot be otherwise than satisfactory to me to find that particular vapor, whose alleged deportment towards radiant heat has been most strenuously denied, affirming thus audibly its true character.

After what has been stated regarding aqueous vapor, we are prepared for the fact that an exceedingly small percentage of any highly athermanous gas diffused in air suffices to exalt the sounds. An accidental observation will illustrate this point. A flask was filled with coal-gas and held bottom upwards in the intermittent beam. The sounds produced were of a force corresponding to the known absorptive energy of coal-gas. The flask was then placed upright, with its mouth open upon a table, and permitted to remain there for nearly an hour. On being restored to the beam, the sounds produced were far louder than those which could be obtained from common air.

Transferring a small flask or a test-tube from a cold place to the intermittent beam, it is sometimes found to be practically silent for a moment, after which the sounds become distinctly audible. This I take to be due to the vaporisation by the calorific beam of the thin film of moisture adherent to the glass.

My previous experiments having satisfied me of the generality of the rule that volatile liquids andtheir vapors absorb the same rays, I thought it probable that the introduction of a thin layer of its liquid, even in the case of a most energetic vapor, would detach the effective rays, and thus quench the sounds. The experiment was made, and the conclusion verified. A layer of water, formic ether, sulphuric ether, or acetic ether, ⅛th of an inch in thickness, rendered the transmitted beam powerless to produce any musical sound. These liquids being transparent to light, the efficient rays which they intercepted must have been those of obscure heat.

A layer of bisulphide of carbon about ten times the thickness of the transparent layers just referred to, and rendered opaque to light by dissolved iodine, was interposed in the path of the intermittent beam. It produced hardly any diminution of the sounds of the more active vapors—a further proof that it is the invisible heat rays, to which the solution of iodine is so eminently transparent, that are here effectual.

Converting one of the small flasks used in the foregoing experiments into a thermometer bulb, and filling it with various gases in succession, it was found that with those gases which yielded a feeble sound, the displacement of a thermometric column associated with the bulb was slow and feeble, while with those gases which yielded loud sounds, the displacement was prompt and forcible.

Received January 10, 1881.

FURTHER EXPERIMENTS.

Since the handing in of the foregoing note, on the 3rd of January, the experiments have been pushed forward; augmented acquaintance with the subject serving only to confirm my estimate of its interest and importance.

All the results described in my first note have been obtained in a very energetic form with a battery of sixty Grove's cells.

On the 4th of January I chose for my source of rays a powerful lime-light, which, when sufficient care is taken to prevent the pitting of the cylinder, works with admirable steadiness and without any noise. I also changed my mirror for one of shorter focus, which permitted a nearer approach to the source of rays. Tested with this new reflector the stronger vapors rose remarkably in sounding power.

Improved manipulation was, I considered, sure to extract sounds from rays of much more moderate intensity than those of the lime-light. For this light, therefore, a common candle flame was substituted. Received and thrown back by the mirror, the radiant heat of the candle produced audible tones in all the stronger vapors.

Abandoning the mirror and bringing the candle close to the rotating disc, its direct rays produced audible sounds.

A red-hot coal, taken from the fire and held close to the rotating disc produced forcible sounds in a flask at the other side.

A red-hot poker, placed in the position previously occupied by the coal, produced strong sounds. Maintaining the flask in position behind the rotating disc, amusing alternations of sound and silence accompanied the alternate introduction and removal of the poker.

The temperature of the iron was then lowered till its heat just ceased to be visible. The intermittent invisible rays produced audible sounds.

The temperature was gradually lowered, being accompanied by a gradual and continuous diminution of the sound. When it ceased to be audible the temperature of the poker was found to be below that of boiling water.

As might be expected from the foregoing experiments, an incandescent platinum spiral, with or without the mirror, produced musical sounds. When the battery power was reduced from ten cells to three, the sounds, though enfeebled, were still distinct.

My neglect of aqueous vapor had led me for a time astray in 1859, but before publishing my results I had discovered my error. On the present occasion this omnipresent substance had also to be reckoned with. Fourteen flasks of various sizes, with their bottoms covered with a little sulphuric acid, were closed with ordinary corks and permitted to remain in the laboratory from the 23d of December to the 4th of January. Tested on the latter day with the intermittent beam, half of them emitted feeble sounds, but half were silent. The sounds were undoubtedly due, not to dry air, but to traces of aqueous vapor.

An ordinary bottle, containing sulphuric acid for laboratory purposes, being connected with the ear and

placed in the intermittent beam, emitted a faint, but distinct, musical sound. This bottle had been opened two or three times during the day, its dryness being thus vitiated by the mixture of a small quantity of common air. A second similar bottle, in which sulphuric acid had stood undisturbed for some days, was placed in the beam: the dry air above the liquid proved absolutely silent.

On the evening of January the 7th, professor Dewar handed me four flasks treated in the following manner. Into one was poured a small quantity of strong sulphuric acid; into another a small quantity of Nordhausen sulphuric acid; in a third were placed some fragments of fused chloride of calcium; while the fourth contained a small quantity of phosphoric anhydride. They were closed with well fitting india-rubber stoppers, and permitted to remain undisturbed throughout the night. Tested after twelve hours, each of them emitted a feeble sound, the flask last mentioned being the strongest. Tested again six hours later, the sound had disappeared from three of the flasks, that containing the phosphoric anhydride alone remaining musical.

Breathing into a flask partially filled with sulphuric acid instantly restores the sounding power, which continues for a considerable time. The wetting of the interior surface of the flask with sulphuric acid always enfeebles, and sometimes destroys the sound.

A bulb, less than a cubic inch in volume, and containing a little water, lowered to the temperature of melting ice, produces very distinct sounds. Warming the water in the flame of a spirit-lamp, the sound becomes greatly augmented in strength. At the boiling temperature the sound emitted by this small bulb* is of extraordinary intensity.

These results are in accord with those obtained by me nearly nineteen years ago, both in reference to air and to aqueous vapor. They are in utter disaccord with those obtained by other experimenters, who have ascribed a high absorption to air and none to aqueous vapor.

The action of aqueous vapor being thus revealed, the necessity of thoroughly drying the flasks, when testing other substances, becomes obvious. The following plan has been found effective. Each flask is first heated in the flame of a spirit-lamp till every visible trace of internal moisture has disappeared, and it is afterwards raised to a temperature of about 400° C. While the flask is still hot, a glass tube is introduced into it and air freed from carbonic acid by caustic potash, and from aqueous vapor by sulphuric acid, is urged through the flask until it is cool. Connected with the ear-tube, and exposed immediately to the intermittent beam, the attention of the ear, if I may use the term, is converged upon the flask. When the experiment is carefully made, dry air proves as incompetent to produce sound as to absorb radiant heat.

In 1868 I determined the absorptions of a great number of liquids whose vapors I did not examine. My experiments having amply proved the parallelism of liquid and vaporous absorption, I held undoubtingly twelve years ago that the vapor of cyanide of ethyl and of acetic acid would prove powerfully absorbent. This conclusion is now easily tested. A small quantity of either of these substances, placed in a bulb a cubic inch in volume, warmed, and exposed to the intermittent beam, emits a sound of extraordinary power.

I also tried to extract sounds from perfumes, which I had proved in 1861 to be absorbers of radiant heat. I limit myself here to the vapors of patchouli and cassia, the former exercising a measured absorption of 30, and the latter an absorption of 109. Placed in dried flasks, and slightly warmed, sounds were obtained from both these substances, but the sound of cassia was much louder than patchouli.

* In such bulbs even bisulphide of carbon vapor may be so nursed as to produce sounds of considerable strength.

Many years ago I had proved tetrachloride of carbon to be highly diathermanous. Its sounding power is as feeble as its absorbent power.

In relation to colliery explosions, the deportment of marsh-gas was of special interest. Professor Dewar was good enough to furnish me with a pure sample of this gas. The sounds produced by it, when exposed to the intermittent beam, were very powerful.

Chloride of methyl, a liquid which boils at the ordinary temperature of the air, was poured into a small flask, and permitted to displace the air within it. Exposed to the intermittent beam, its sound was similar in power to that of marsh-gas.

The specific gravity of marsh gas being about half that of air, it might be expected that the flask containing it, when left open and erect, would soon get rid of its contents. This, however, is not the case. After a considerable interval, the film of this gas clinging to the interior surface of the flask was able to produce sounds of great power.

A small quantity of liquid bromine being poured into a well-dried flask, the brown vapor rapidly diffused itself in the air above the liquid. Placed in the intermittent beam, a somewhat forcible sound was produced. This might seem to militate against my former experiments, which assigned a very low absorptive power to bromine vapor. But my former experiments on this vapor were conducted with obscure heat; whereas, in the present instance, I had to deal with the radiation from incandescent lime, whose heat is, in part, luminous. Now, the color of the bromine vapor proves it to be an energetic absorber of the luminous rays; and to them, when suddenly converted into thermometric heat in the body of the vapor, I thought the sounds might be due.

Between the flash containing the bromine and the rotating disc I therefore placed an empty glass cell: the sounds continued. I then filled the cell with transparent bisulphide of carbon: the sounds still continued. For the transparent bisulphide I then substituted the same liquid saturated with dissolved iodine. This solution cut off the light, while allowing the rays of heat free transmission: the sounds were immediately stilled.

Iodine vaporised by heat in a small flask yielded a forcible sound, which was not sensibly affected by the interposition of transparent bisulphide of carbon, but which was completely quelled by the iodine solution. It might indeed have been foreseen that the rays transmitted by the iodine as a liquid would also be transmitted by its vapor, and thus fail to be converted into sound.*

To complete the argument:—While the flask containing the bromine vapor was sounding in the intermittent beam, a strong solution of alum was interposed between it and the rotating disc. There was no sensible abatement of the sounds with either bromine or iodine vapor.

In these experiments the rays from the lime-light were converged to a point a little beyond the rotating disc. In the next experiment they were rendered parallel by the mirror, and afterwards rendered convergent by a lens of ice. At the focus of the ice lens the sounds were extracted from both bromine and iodine vapor. Sounds were also produced after the beam had been sent through the alum solution and the ice lens conjointly.

With a very rude arrangement I have been able to hear the sounds of the more active vapors at a distance of 100 feet from the source of rays.

Several vapors other than those mentioned in this abstract have been examined, and sounds obtained from all of them. The vapors of all compound liquids will, I doubt not, be found sonorous in the intermittent beam. And, as I question whether there is an absolutely diathermanous substance in nature, I think it probable that

* I intentionally use this phraseology.

even the vapors of elementary bodies, including the elementary gases, when more strictly examined, will be found capable of producing sounds.

THE UNITY OF NATURE.

By the Duke of Argyll.

VI.

(*Continued from page* 103.)

ON THE MORAL CHARACTER OF MAN, CONSIDERED IN THE LIGHT OF THE UNITY OF NATURE.

In dealing with this question, it is a comfort to remember that we are in possession of analogies deeply seated in the constitution and in the course of Nature. It is quite possible to assign to Intuition or to Instinct the place and rank which really belongs to it, and to assign also to what is called Experience the functions which are unquestionably its own. There is no sense or faculty of the mind which does not gain by education—not one which is independent of those processes of development which result from its contact with the external world. But neither is there any sense or faculty of the mind which starts unfurnished with some one or more of those intuitive perceptions with which all education and all development must begin. Just as every exercise of reason must be founded on certain axioms which are self-evident to the logical faculty, so all other exercises of the mind must start from the direct perception of some rudimentary truths. It would be strange indeed if the moral faculty were any exception to this fundamental law. This faculty in its higher conditions, such as we see it in the best men in the most highly civilized communities, may stand at an incalculable distance from its earliest and simplest condition, and still more from its lowest condition, such as we see it in the most degraded races of mankind. But this distance has been reached from some starting-point, and at that starting-point there must have been some simple acts or dispositions to which the sense of obligation was instinctively attached. And beyond all question this is the fact. All men do instinctively know what gives pleasure to themselves, and therefore also what gives pleasure to other men. Moreover, to a very large extent, the things which give them pleasure are the real needs of life, and the acquisition or enjoyment of these is not only useful but essential to the well-being or even to the very existence of the race. And as Man is a social animal by nature, with social instincts at least as innate as those of the Ant or the Beaver or the Bee, we may be sure that there were and are born with him all those intuitive perceptions and desires which are necessary to the growth and unfolding of his powers. And this we know to be the fact, not only as a doctrine founded on the unities of Nature, but as a matter of universal observation and experience. We know that without the Moral Sense Man could not fulfill the part which belongs to him in the world. It is as necessary in the earliest stages of the Family and of the Tribe, as it is in the latest developments of the State and of the Church. It is an element without which nothing can be done—without which no man could trust another, and, indeed, no man could trust himself. There is no bond of union among men—even the lowest and the worst—which does not involve and depend upon the sense of obligation. There is no kind of brotherhood or association for any purpose which could stand without it. As a matter of fact, therefore, and not at all as a matter of speculation, we know that the Moral Sense holds a high place as one of the necessary conditions in the development of Man's nature, in the improvement of his condition, and in the attainment of that place which may yet lie before him in the future of the world. There are other sentiments and desires, which, being as needful, are equally instinctive. Thus, the desire of communicating pleasure to others is one of the instincts which is as universal in Man as the desire of communicating knowledge. Both are indeed branches of the same stem—off-shoots from the same root. The acquisition of knowledge, to which we are stimulated by the instinctive affections of curiosity and of wonder, is one of the greatest of human pleasures, and the desire we have to communicate our knowledge to others is the great motive-force on which its progress and accumulation depend. The pleasure which all men take, when their dispositions are good, in sharing with others their own enjoyments, is another feature quite as marked and quite as innate in the character of Man. And if there is any course of action to which we do instinctively attach the sentiment of moral approbation, it is that course of action which assumes that our own desires, and our own estimates of good, and the standard by which we ought to judge of what is due to and is desired by others. The social instincts of our nature must, therefore, naturally and intuitively indicate benevolence as a virtuous, and malevolence as a vicious disposition; and, again, our knowledge of what is benevolent and what is malevolent is involved in our own instinctive sense of what to us is good, and of what to us is evil. It is quite true that this sense may be comparatively low or high, and consequently that the standard of obligation which is founded upon it may be elementary and nothing more. Those whose own desires are few and rude, and whose own estimates of good are very limited, must of course form an estimate correspondingly poor and scant of what is good for, and of what is desired by, others. But this exactly corresponds with the facts of human nature. This is precisely the variety of unity which its phenomena present. There are no men of sane mind in whom the Moral Sense does not exist; that is to say, there are no men who do not attach to some actions or other the sentiment of approval, and to some other actions the opposite sentiment of condemnation. On the other hand, the selection of the particular actions to which these different sentiments are severally attached is a selection immensely various; there being, however, this one common element in all—that the course of action to which men do by instinct attach the feeling of moral obligation, is that course of action which is animated by the feeling that their own desires and their own estimate of good is the standard by which they must judge of what is due by them to others, and by others to themselves.

And here we stand at the common point of departure from which diverge the two great antagonistic schools of ethical philosophy. On the other hand in the intuitive and elementary character which we have assigned to the sentiment of obligation, considered in itself, we have the fundamental position of that school which asserts an independent basis of morality; whilst, on the other hand, in the elementary truths which we have assigned to the Moral Sense as its self-evident apprehensions, we have a rule which corresponds, in one aspect at least, to the fundamental conception of the Utilitarian school. For the rule which connects the idea of obligation with conduct tending to the good of others, as tested by our own estimate of what is good for ourselves, is a rule which clearly brings the basis of morality into very close connection with the practical results of conduct. Accordingly, one of the ablest modern advocates of the Utilitarian system has declared that "in the golden rule of Jesus of Nazareth we read the complete spirit of the ethics of Utility. To do as you would be done by, and to love your neighbor as yourself, constitute the ideal perfection of Utilitarian morals."[2]

This may well seem a strange and almost a parodoxical result to those who have been accustomed to consider the Utilitarian theory not so much a low standard of morals, as an idea which is devoid altogether of that ele-

[2] J. S. Mill: "Utilitarianism," pp. 24, 25.

ment in which the very essence of morality consists. But it is a result due to these two causes—first, that under the fire of controversy Utilitarians have been obliged to import into the meaning of their words much that does not really belong to them; and secondly, to the fact, that when this essential alteration has been made, then the theory, or rather the portion of it which remains, does represent one very important aspect of a very complex truth.

It will be well to examine a little more closely the different ways in which these two causes operate.

In the first place, as regards the ambiguities of language, a moment's consideration will convince us that the word "utility" has, in its proper and primary signification, nothing whatever of the ethical meaning which is attached to it in the Utilitarian theory of morals. In its elementary signification the useful is simply the serviceable. It is curious to observe that this last word has no ethical savor about it. On the contrary, it is associated rather with the lower uses than with the higher of conduct. If this be objected to as preventing the two words from being really the equivalent of each other, then at least let it be recognized that utility must be divested of its ethical associations before it can be set up as an ethical test. If utility is first assumed to be the equivalent of goodness, it becomes of course a mere play on words to represent usefulness as the criterion of virtue. If we are to conduct our analysis correctly, we must expel from utility every adventitious element of meaning. The usefulness of a thing means nothing more than its conduciveness to some purpose. But it may be any purpose,—morally good, or morally bad, or morally indifferent. The boot-jack, the thumb-screw, and the rack are all useful machines for the purpose of producing torture on the victim, and for the purpose, too, of giving to the torturers that pleasure or satisfaction which wicked men find in tyranny or revenge. The words "good" and "bad" are themselves often used in a secondary and derivative sense, which, like "useful," may be destitute of any ethical meaning. A good thumb-screw would mean an implement well adapted to produce the most exquisite pain. A good torture may mean a torture well calculated to gratify the savage sentiment of revenge. In like manner, although not to the same extent, the words "right" and "wrong" are often used with no ethical element of meaning. The right way for a man who wishes to commit suicide would be the way to a precipice over which he desires to throw himself. But the same way is the wrong way for him, if he wishes to avoid the danger of falling. In this way we may speak of the right way of doing the most wicked things. One most eminent expounder of the Utilitarian theory has taken advantage of this common use of the words "good" and "bad," and of "right" and wrong," to represent utility and inutility to be the essential idea of all goodness and of all badness respectively.[3] Thus the unavoidable ambiguities of speech are employed to give a scientific aspect to the confounding and obliteration of the profoundest distinctions which exist in knowledge. By the double process of expelling from goodness the idea of virtue, and of inserting into utility the idea of beneficence, the fallacies of language become complete. Because subserviency to purpose of any kind is the meaning of "good," when applied equally to an instrument of torture and to an instrument for the relief of suffering, therefore, it is argued, the same meaning must be the essential one when we speak of a good man. And so indeed it may be, if we know or assume beforehand what the highest purpose is to which Man can be made subservient. There is a well-known Catechism of one of the Reformed churches which opens with the question, "What is the chief end of Man?" The answer is perhaps one of the noblest in the whole compass of theology. "Man's chief end is to glorify God and to enjoy Him forever."[4] Given certain further beliefs as to the character of the Divine Being, and the methods of his Government, then indeed it would be true that this is a conception of the purpose of Man's existence which would erect mere serviceableness or utility into a perfect rule of conduct. Perhaps even a lower or less perfect conception of the great aim of Man's life would be almost enough. If virtue and beneficence are first assumed to be the highest purpose of his being, then subserviency to that purpose may be all that is meant by goodness. But, without this assumption as to the "chief end of Man," there would be no ethical meaning whatever in the phrase of "a good man." It might mean a good thief, or a good torturer, or a good murderer. Utility, that is to say, mere subserviency to any purpose, is undoubtedly a good thing in itself, and of this kind is the goodness of a machine which is invented for a bad or evil purpose. But this utility in the machine is, so far as the machine is concerned, destitute of any moral character whatever, and, so far as those who employ it are concerned, the utility is not virtuous, but, on the contrary, it is vicious. It is clear, therefore, that when the word "utility" is used as meaning moral or even physical good, and still more when it is identified with virtue, or when it is declared to be the standard of that which is right or virtuous in conduct, the word is used not in its own proper sense, but in a special or adventitious sense, in which it is confined to one special kind of usefulness, namely, that which conduces to good ends, and good aims, and good purposes. That is to say, the sense in which utility is spoken of as the test or standard of virtue is a sense which assumes that goodness and virtue are independently known, or, in other words, that they are determined and recognized by some other test and some other standard.

It is, however, clear that when by this other test and standard, whatever it may be, we have already felt or apprehended that it is right and virtuous to do good to others, then the usefulness of any action or of any course of conduct, in the production of such good, does become a real test and indication of that which we ought to do. It is a test or indication of the particular things which it is right to do, but not at all a test of the moral obligation which lies upon us to do them. This obligation must be assumed, and is assumed, in every argument on the moral utility of things. It is by confounding these two very distinct ideas that the Utilitarian theory of the ultimate basis of moral obligation has so long maintained a precarious existence, borrowing from the misuse of words a strength which is not its own. But the moment this distinction is clearly apprehended, then, although we set aside the bare idea of usefulness, apart from the good or bad purpose towards which that usefulness conduces, as affording any explanation whatever of the ultimate nature and source of duty, we may well, nevertheless, be ready to adopt all that the Utilitarian theory can show us of that inseparable unity which is established in the constitution of the world between the moral character and the ultimate results of conduct. As far as these results can be traced beforehand, and in proportion as they can be traced farther and farther in the light of expanding knowledge, they do indicate the path of duty. They do indicate the line of action which is obligatory on voluntary agents, to whom a very large amount of power is given in directing the course of things. Beyond all doubt there are a thousand acts and a thousand courses of conduct which are in accordance with the Moral Sense, because and only because of the known happiness of their effects. This is the fact, or rather the class of facts, which has in all ages recommended the Utilitarian theory of morals to so many powerful minds. For, indeed, if we understand by utility not the low or limited idea of mere usefulness for any purpose—not even the

[3] Herbert Spencer: "Data of Ethics," chap. iii.

[4] "The Shorter Catechism, presented by the Westminster Assembly of Divines to both Houses of Parliament, and by them approved."

mere idea of pleasure as an unquestionable good of its own kind, nor the mere idea of immediate profit or advantage---but the very different conception of the beneficence of ultimate results on the welfare of all men and of all creatures, then there may be, and probably there is, an universal and absolute coincidence between the things which it is wise and the things which it is right to do. Men may imagine, and they have imagined, that under this conception of utility they can devise a system of morality which is of such transcendental excellence that it is far too good for earth. Thus it has been laid down that evolution, in its most perfect conception, would be such that the development of every creature would be compatible with the equal development of every other. In such a system there would be no "struggle for existence—no harmful competition, no mutual devouring —no death."[5] The inspired imaginings of the Jewish prophets of some future time when the lion shall lie down with the lamb, and the ideas which have clustered round the Christian Heaven, are more probably the real origin of this conception than any theory of evolution founded on the facts and laws of Nature. But, for all practical purposes, such a system of ethics is as useless as the dreams of Plato's Republic or of More's Utopia. If, however, we have got from some independent source a right idea of that which will be most beneficent in its ultimate results, we may well be guided by this light in so far as we can see it. But inasmuch as these far-off results and tendencies of conduct cannot always be within sight, and are indeed very often wholly beyond the horizon visible to us, this admission, or rather this high doctrine that the right and the useful are always coincident, is a widely different doctrine from that which identifies the sense of obligation with the perception of utility. The mere perception that any act or course of conduct will certainly be beneficent in its results, would be of no avail without the separate feeling that it is right to strive for results which are beneficent.

And here it is well worthy of observation, that in direct proportion to the height and sublimity of the meaning artificially attached to the word "utility," it becomes less and less available as a test or as a rule of conduct. So long as the simple and natural meaning was put upon utility, and the good was identified with the pleasurable, the Utilitarian theory of morals did indicate at least some rule of life, however low that rule might be. But now that the apostles of that theory have been driven to put upon utility a transcendental meaning, and the pleasurable is interpreted to refer not merely to the immediate and visible effects of conduct on ourselves or others, but to its remotest effects upon all living beings, both now and for all future time, the Utilitarian theory in this very process of sublimation becomes lifted out of the sphere of human judgment. If it be true "that there can be no correct idea of a part without a correct idea of the correlative whole," and if human conduct in its tendencies and effects is only "a part of universal conduct,"[6]—that is to say, of the whole system of the universe in its past, its present, and its future—then, as this whole is beyond all our means of knowledge and comprehension, it follows that utility, in this sense, can be no guide to us. If indeed this system of the universe has over it or in it one Supreme Authority, and if we knew on that authority the things which do make, not only for our own everlasting peace, but for the perfect accomplishment of the highest purposes of creation to all living things, then indeed the rule of utility is resolved into the simple rule of obedience to legitimate Authority. And this is consistent with all we know of the Unity of Nature, and with all that we can conceive of the central and ultimate Authority on which its order rests. All intuitive perceptions come to us from that Authority. All the data of reason come to us from that Authority. All these in their own several spheres of operation may well guide us to what is right, and may give us also the conviction that what is right is also what is best, "at last, far off, at last to all."

Thus far a clear and consistent answer can be given to one of the greatest questions of ethical inquiry, namely, the nature of the relation between those elements in conduct which make it useful, and those elements in conduct which make it virtuous. The usefulness of conduct in promoting ends and purposes which are good is, in proportion to the nature and extent of that good, a test and an index of its virtue. But the usefulness of conduct in promoting ends and purposes which are not good is a mark and index, not of virtue, but of vice. It follows from this that utility in itself has no moral character whatever apart from the particular aim which it tends to accomplish, and that the moral goodness of that aim is presupposed when we speak or think of the utility of conduct as indicative of its virtue. But this character of goodness must be a matter of independent and instinctive recognition, because it is the one distinction between the kind of usefulness which is virtuous and the many kinds of usefulness which are vicious. Accordingly we find in the last resort that our recognition of goodness in the conduct of other men towards ourselves is inseparable from our own consciousness of the needs and wants of our own life, and of the tendency of that conduct to supply them. This estimate of goodness seated in the very nature of our bodies and of our minds, becomes necessarily, also, a standard of obligation as regards our conduct to others; for the unity of our nature with that of our kind and fellows is a fact seen and felt intuitively in the sound of every voice and in the glance of every eye around us.

But this great elementary truth of morals, that we ought to do to others as we know we should wish them to do to us, is not the only truth which is intuitively perceived by the Moral Sense. There is, at least, one other among the rudiments of duty which is quite as self-evident, quite as important, quite as far-reaching in its consequences, and quite as early recognized. Obedience to the will of legitimate Authority is necessarily the first of all motives with which the sense of obligation is inseparably associated; whilst its opposite, or rebellion against the commands of legitimate Authority, is the spirit and the motive upon which the Moral Sense pronounces its earliest sentence of disapproval and of condemnation. At first sight it may seem as if the legitimacy of any Authority is a previous question requiring itself to be determined by the Moral Sense, seeing that it is not until this character of legitimacy or rightfulness has been recognized as belonging to some particular Authority, that obedience to its commands comes in consequence to be recognized as wrong. A moment's consideration, however, will remind us that there is at least one Authority the rightfulness of which is not a question but a fact. All men are born of parents. All men, moreover, are born in a condition of utter helplessness and of absolute dependence. As a mattor of fact, therefore, and not at all as a matter of question or of doubt, our first conception of duty, or of moral obligation, is necessarily and universally attached to such acts as are in conformity with the injunctions of this last and most indisputable of all Authorities.

Standing, then, on this firm ground of universal and necessary experience, we are able to affirm with absolute conviction that our earliest conceptions of duty—our earliest exercises of the Moral Sense—are not determined by any considerations of utility, or by any conclusions of the judgment on the results or on the tendencies of conduct.

But the same reasoning, founded on the same principle of simply investigating and ascertaining facts, will carry us a great way farther on. As we grow up from infancy, we find that our parents are themselves also subject to Authority, owing and owning the duty of obedi-

[5] Herbert Spencer: "Data of Ethics," chap. ii. pp. 18, 19.

[6] Herbert Spencer: "Dara of Ethics," chap. i. pp. 1-6.

ence to other persons or to other powers. This higher Authority may be nothing but the rules and customs of a rude tribe; or it may be the will of an absolute sovereign; or it may be the accumulated and accepted traditions of a race; or it may be the laws of a great civilized community; or it may be the Authority, still higher, of that Power which is known or believed to be supreme in Nature. But in all and in each of these cases, the sense of obligation is inseparably attached to obedience to some Authority, the legitimacy or rightfulness of which is not itself a question but a fact.

It is true, indeed, that these rightful Authorities, which are enthroned in Nature, are fortified by power to enforce their commands, and to punish violations of the duty of obedience. It is true, therefore, that from the first moments of our existence the sense of obligation is re-inforced by the fear of punishment. And yet we know, both as a matter of internal consciousness, and as a matter of familiar observation in others, that this sense of obligation is not only separable from the fear of punishment, but is even sharply contra-distinguished from it. Not only is the sense of obligation powerful in cases where the fear of punishment is impossible, but in direct proportion as the fear of punishment mixes or prevails, the moral character of an act otherwise good is diminished or destroyed. The fear of punishment and the hope of reward are, indeed, auxiliary forces which cannot be dispensed with in society. But we feel that complete goodness and perfect virtue would dispense with them altogether, or rather, perhaps, it would be more correct to say, that the hope of reward would be merged and lost as a separate motive in that highest condition of mind in which the performance of duty becomes its own reward, because of the satisfaction it gives to the Moral Sense, and because of the love borne to that Authority whom we feel it our duty to obey.

The place occupied by this instinctive sentiment in the equipment of our nature is as obvious as it is important. The helplessness of infancy and of childhood is not greater than would be the helplessness of the race if the disposition to accept and to obey Authority were wanting in us. It is implanted in our nature only because it is one of the first necessities of our life, and a fundamental condition of the development of our powers. All Nature breathes the spirit of authority, and is full of the exercise of command. "Thou shalt," or "Thou shalt not," are words continually on her lips, and all her injunctions and all her prohibitions are backed by the most tremendous sanctions. Moreover, the most tremendous of these sanctions are often those which are not audibly proclaimed, but those which come upon us most gradually, most imperceptibly, and after the longest lapse of time. Some of the most terrible diseases which afflict humanity are known to be the results of vice, and what has long been known of some of those diseases is more and more reasonably suspected of many others. The truth is, that we are born into a system of things in which every act carries with it, by indissoluble ties, a long train of consequences reaching to the most distant future, and which for the whole course of time affect our own condition, the condition of other men, and even the conditions of external nature. And yet we cannot see those consequences beyond the shortest way, and very often those which lie nearest are in the highest degree deceptive as an index to ultimate results. Neither pain nor pleasure can be accepted as a guide. With the lower animals, indeed, these, for the most part, tell the truth, the whole truth, and nothing but the truth. Appetite is all that the creature has, and in the gratification of it the highest law of the animal being is fulfilled. In Man, too, appetite has its own indispensable function to discharge. But it is a lower function, and amounts to nothing more than that of furnishing to Reason a few of the primary data on which it has to work—a few and a few only. Physical pain is indeed one of the threatenings of natural authority; and physical pleasures is one of its rewards. But neither the one nor the other forms more than a mere fraction of that awful and imperial code under which we live. It is the code of an everlasting Kingdom, and of a jurisprudence which endures throughout all generations. It is a code which continually imposes on Man the abandonment of pleasure, and the endurance of pain, whenever and wherever the higher purposes of its law demand of him the sacrifice. Nor has this spirit of Authority ever been without its witness in the human Spirit, or its response in the human Will. On the contrary, in all ages of the world, dark and distorted as have been his understandings of Authority, Man has been prone to acknowledge it, and to admit it as the basis of obligation and the rule of duty. This, at all events, is one side of his character, and it is universally recognized as the best.

There is no difficulty, then, in seeing the place which this instinct holds in the unity of Nature. It belongs to that class of gifts, universal in the world, which enable all living things to fulfill their part in the order of Nature, and to discharge the functions which belong to it. It is when we pass from a review of those instincts and powers with which Man has been endowed, to a review of their actual working and results, that we for the first time encounter facts which are wholly exceptional, and which it is, accordingly, most difficult to reconcile with the unities of Nature. This difficulty does not lie in the mere existence of a Being with powers which require for their perfection a long process of development. There is no singularity in this. On the contrary, it is according to the usual course and the universal analogy of Nature. Development in different forms, through a great variety of stages and at different rates of progress, is the most familiar of all facts in creation. In the case of some of the lower animals, and especially in the case of many among the lowest, the process of development is carried to an extent which may almost be said to make the work of creation visible. There are numberless creatures which pass through separate stages of existence having no likeness whatever to each other. In passing through these stages, the same organism differs from itself in form, in structure, in the food on which it subsists, and even in the very element in which it breathes and lives. Physiologists tell us that changes having a mysterious and obscure analogy with these pass over the embryo of all higher animals before their birth. But after birth the development of every individual among the higher orders of creation is limited to those changes which belong to growth, to maturity, and decay. Man shares in these changes, but in addition to those he undergoes a development which effects him not merely as an individual, but as a species and a race. This is purely a development of mind, of character, and of knowledge, giving by accumulation from generation to generation increased command over the resources of Nature, and a higher understanding of the enjoyments and of the aims of life.

It is true, indeed, that this is a kind of development which is itself exceptional—that is to say, it is a kind of development of which none of the lower animals are susceptible, and which therefore separates widely between them and Man. But although it is exceptional with reference to the lower orders of creation it is very important to observe that it constitutes no anomaly when it is regarded in connection with creation as a whole. On the contrary, it is the natural and necessary result of the gift of reason and of all those mental powers which are its servants or allies. But all Nature is full of these—so full, that every little bit and fragment of its vast domain overflows with matter of inexhaustible interest to that one only Being who has the impulse of inquiry and the desire to know. This power or capacity in every department of Nature of fixing the attention and of engrossing the interest of Man,

depends on the close correspondence between his own faculties and those which are reflected in creation, and on his power of recognizing that correspondence as the highest result of investigation. The lower animals do reasonable things without the gift of reason, and things, as we have seen, often involving a very distant foresight, without having themselves any knowledge of the future. They work for that which is to be, without seeing or feeling anything beyond that which is. They enjoy, but they cannot understand. Reason is, as it were, brooding over them and working through them, whilst at the same time it is wanting in them. Between the faculties they possess, therefore, and the governing principles of the system in which they live and under which they serve, there is, as it were, a vacant space. It is no anomaly that this space should be occupied by a Being with higher powers. On the contrary, it would be the greatest of all anomalies if it were really vacant. It would be strange indeed if there were no link connecting, more closely than any of the lower animals can connect, the Mind that is in creation with the mind that is in the creature. This is the place occupied by Man's Reason—Reason not outside of, but in the creature—working not only through him, but also in him—Reason conscious of itself, and conscious of the relation in which it stands to that measureless Intelligence of which the Universe is full. In occupying this place, Man fills up, in some measure at least, what would otherwise be wanting to the continuity of things; and in proportion as he is capable of development—in proportion as his faculties are expanded—he does fill up this place more and more.

There is nothing, then, really anomalous or at variance with the unity of Nature, either in the special elevation of the powers which belong to Man, or in the fact that they start from small beginnings and are capable of being developed to an extent which, though certainly not infinite is at least indefinite. That which is rarely exceptional, and indeed absolutely singular in Man, is the persistent tendency of his development to take a wrong direction. In all other creatures it is a process which follows a certain and determined law, going straight to a definite, consistent, and intelligible end. In Man alone it is a process which is prone to take a perverted course, tending not merely to arrest his progress, but to lead him back along descending paths to results of utter degradation and decay. I am not now affirming that this has been the actual course of Man as a species or as a race when that course is considered as a whole. But that it is often the course of individual men, and that it has been the course of particular races and generations of men in the history of the world, is a fact which cannot be denied. The general law may be a law of progress; but it is certain that this law is liable not only to arrest but to reversal. In truth it is never allowed to operate unopposed, or without heavy deductions from its work. For there is another law ever present, and ever working in the reverse direction. Running alongside, as it were, of the tendency to progress, there is the other tendency to retrogression. Between these two there is a war which never ceases,—sometimes the one, sometimes the other, seeming to prevail. And even when the better and higher tendency is in the ascendant, its victory is qualified and abated by its great opponent. For just as in physics the joint operation of two forces upon any moving body results in a departure from the course it would have taken if it had been subject to one alone, so in the moral world almost every step in the progress of mankind deviates more or less from the right direction. And every such deviation must and does increase, until much that had been gained is again lost, in new developments of corruption and of vice. The recognition of this fact does not depend on any particular theory as to the nature or origin of moral distinctions. It is equally clear, whether we judge according to the crudest standard of the Utilitarian scheme, or according to the higher estimates of an Independent Morality. Viewed under either system, the course of development in Man cannot be reconciled with the ordinary course of Nature, or with the general law under which all other creatures fulfill the conditions of their being.

It is no mere failure to realize aspirations which are vague and imaginary that constitutes this exceptional element in the history and in the actual condition of mankind. That which constitutes the terrible anomaly of his case admits of perfectly clear and specific definition. Man has been and still is a constant prey to appetites which are morbid—to opinions which are irrational, to imaginations which are horrible, and to practices which are destructive. The prevalence and the power of these in a great variety of forms and of degrees is a fact with which we are familiar—so familiar, indeed, that we fail to be duly impressed with the strangeness and the mystery which really belong to it. All savage races are bowed and bent under the yoke of their own perverted instincts—instincts which generally in their root and origin have an obvious utility, but which in their actual development are the source of miseries without number and without end. Some of the most horrible perversions which are prevalent among savages have no counterpart among any other created beings, and when judged by the barest standard of utility, place Man immeasurably below the level of the beasts. We are accustomed to say of many of the habits of savage life that they are "brutal." But this is entirely to misrepresent the place which they really occupy in the system of Nature. None of the brutes have any such perverted dispositions; none of them are ever subject to the destructive operation of such habits as are common among men. And this contrast is all the more remarkable when we consider that the very worst of these habits affect conditions of life which the lower animals share with us, and in which any departure from those natural laws which they universally obey, must necessarily produce, and do actually produce, consequences so destructive as to endanger the very existence of the race. Such are all those conditions of life affecting the relation of the sexes which are common to all creatures, and in which Man alone exhibits the widest and most hopeless divergence from the order of Nature.

It fell in the way of Malthus in his celebrated work on Population to search in the accounts of travelers for those causes which operate, in different countries of the world, to check the progress, and to limit the numbers of Mankind. Foremost among these is vice, and foremost among the vices is that most unnatural one, of the cruel treatment of women. "In every part of the world," says Malthus, "one of the most general characteristics of the savage is to despise and degrade the female sex. Among most of the tribes in America, their condition is so peculiarly grievous, that servitude is a name too mild to describe their wretched state. A wife is no better than a beast of burden. While the man passes his days in idleness or amusement, the woman is condemned to incessant toil. Tasks are imposed upon her without mercy, and services are received without complacence or gratitude. There are some districts in America where this state of degradation has been so severely felt that mothers have destroyed their female infants, to deliver them at once from a life in which they were doomed to such a miserable slavery."[7] It is impossible to find for this most vicious tendency any place among the unities of Nature. There is nothing like it among the beasts. With them the equality of the sexes, as regards all the enjoyments as well as all the work of life, is the universal rule. And among those of them in which social instincts have been specially implanted, and whose system of polity are like the most civilized polities of men, the females of the race are treated with a strange mixture of love, of loyalty, and of devotion. If, indeed, we consider

the necessary and inevitable results of the habit prevalent among savage men to maltreat and dagrade their women,—its effects upon the constitution, and character, and endurance of children, we cannot fail to see how grossly unnatural it is, how it must tend to the greater and greater degradation of the race, and how recovery from this downward path must become more and more difficult or impossible. But vicious, destructive, unnatural as this habit is, it is not the only one or the worst of similar character which prevail among savage men. A horrid catalogue comes to our remembrance when we think of them—polyandry, infanticide, cannibalism, deliberate cruelty, systematic slaughter connected with warlike passions or with religious customs. Nor are these vices, or the evils resulting from them, peculiar to the savage state. Some of them, indeed, more or less changed and modified in form, attain a rank luxuriance in civilized communities, corrupt the very bones and marrow of society, and have brought powerful nations to decay and death.

It is, indeed, impossible to look abroad either upon the past history or the existing condition of mankind, whether savage or civilized, without seeing that it presents phenomena which are strange and monstrous—incapable of being reduced within the harmony of things or reconciled with the unity of Nature. The contrasts which it presents to the general laws and course of Nature cannot be stated too broadly. There is nothing like it in the world. It is an element of confusion amidst universal order. Powers exceptionally high spending themselves in activities exceptionally base; the desire and the faculty of acquiring knowledge coupled with the desire and the faculty of turning it to the worst account; instincts immeasurably superior to those of other creatures, along side of conduct and of habits very much below the level of the beasts—such are the combinations with which we have to deal as unquestionable facts when we contemplate the actual condition of Mankind. And they are combinations in the highest degree unnatural; there is nothing to account for, or to explain them in any apparent natural necessity.

The question then arises, as one of the greatest of all mysteries—how it is and why it is that the higher gifts of Man's nature should not have been associated with corresponding dispositions to lead as straight and as unerringly to the crown and consummation of his course, as the dispositions of other creatures do lead them to the perfect development of their powers and the perfect discharge of their functions in the economy of Nature?

It is as if weapons had been placed in the hands of Man which he has not the strength, nor the knowledge, nor the rectitude of will to wield aright. It is in this contrast that he stands alone. In the light of this contrast we see that the corruption of human nature is not a mere dogma of theology, but a fact of science. The nature of man is seen to be corrupt not merely as compared with some imaginary standard which is supposed to have existed at some former time, but as compared with a standard which prevails in every other department of Nature at the present day. We see, too, that the analogies of creation are adverse to the supposition that this condition of things was original. It looks as if something exceptional must have happened. The rule throughout all the rest of Nature is, that every creature does handle the gifts which have been given to it with a skill as wonderful as it is complete, for the highest purposes of its being, and for the fulfillment of its part in the unity of creation. In Man alone we have a being in whom his adjustment is imperfect—in whom this faculty is so defective as often to miss its aim. Instead of unity of law with certainty and harmony of result, we have antagonism of laws, with results, at the best, of much shortcoming and often of hopeless failure. And the anomaly is all the greater when we consider that this failure affects chiefly that portion of Man's nature which has the direction of the rest—on which the whole result depends, as regards his conduct, his happiness, and his destiny. The general fact is this:—First, that Man is prone to set up and to invent standards of obligations which are low, false, mischievous, and even ruinous; and secondly, that when he has become possessed of standards of obligation which are high, and true, beneficient, he is prone first, to fall short in the observance of the , and next, to suffer them, through various processes of decay, to be obscured and lost.

[7] Malthus, 6th Edition, vol. i., p. 39.

ASTRONOMY.

THE LICK OBSERVATORY.

Work upon Mount Hamilton, the site of the new Lick Observatory, has been pushed forward as rapidly as could be expected, and it is probable that the building will be sufficiently finished to receive a portion of the instruments in the fall of this year. For instrumental equipment, a 12-inch Clark glass and tube, made for Dr. Draper, has been bought, and will be fitted to an equatorial mounting. A 4-inch transit, made on the same patterns as the 4-inch meridian circle of Princeton College, with a few changes introduced by Professors Newcomb and Holden, has been ordered from Fauth & Co., of Washington. It will be sent to California in October, and will probably be mounted by Prof. Holden, and used by him in connection with the 12-inch equatorial, to observe the transit of Mercury on November 7, 1881. A Repsolds meridian circle of six inches aperture will soon be ordered, as well as a small vertical circle. Alvan Clark & Sons, of Cambridge, have received the contract to make a glass three feet in diameter, at a cost of $50,000. The equatorial mounting for this immense objective (44 per cent. more powerful than that ordered for the Russian Government, with aperture of 30 inches, and 100 per cent. more powerful than the great Washington refractor) is not yet provided for. Proposals will be obtained from the principal instrument makers of Europe and this country, and the mechanical part will probably cost as much as the optical.

General plans for the buildings were prepared by Professors Newcomb and Holden, in August, 1880, and will govern the more detailed plans which are to be prepared by the architects. A dome for the 12-inch equatorial is already in process of construction.

The work done upon Mt. Hamilton by Mr. Burnham in the summer of 1879 shows how well suited the high situation is for astronomical observations, and much will be expected from an observatory so well provided with powerful instruments.

"THE 'ASTRONOMISCHE NACHRICHTEN.'—Contrary to what has been lately stated, it appears that this periodical will still be edited by Dr. C. F. W. Peters, who has for some time conducted it, and we are informed there is a probability that Prof. Kruger may set afloat a new astronomical journal under his own management."—*Nature.*

SITE FOR THE NEW NAVAL OBSERVATORY.—The Commission appointed by Congress to select a site for the proposed new Naval Observatory has purchased the Barbour estate, in Georgetown, at a cost of $63,000. A detailed description of the location will shortly appear.

W. C. W.

WASHINGTON, *March* 10, 1881.

We notice, in the last number of the *Chemical News*, that Mr. M. Benjamin, to whom we are indebted for notices of the American Chemical Society, was elected a Fellow of the Chemical Society, London.

CORRESPONDENCE.

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. No notice is taken of anonymous communications.*]

MICROSCOPY.

To the Editor of "SCIENCE:"

Dear Sir:—I am authorized by the President of the American Society of Microscopists to announce to its members, and to all others who may be interested, that the Executive Committee have decided, by an almost unanimous vote, to accept the invitation received from the Tyndall Association of Natural Science, of Columbus, Ohio, and to call the next meeting of the Society at that place on Tuesday, August 9, 1881, (the week previous to the meeting of the American Association for the Advancement of Science, at Cincinnati).

Permit me to add a word upon another matter. The proceedings of the American Society, which should have appeared two months ago, have been unavoidably delayed by circumstances which I shall explain to members at the time of issuing the volume. The latter is now in the press, and will be sent out before the end of the month. ALBERT H. TUTTLE, Sec'y.

COLUMBUS, Ohio, *March* 1, 1881.

BOOKS RECEIVED.

BACTERIA. BY DR. ANTOINE MAGNIN, General Secretary of the Botanical Society of Lyons, &c., &c. Translated by George M. Sternberg, M. D., U. S. A. Boston—Little, Brown, & Company. 1880. Price $2.50.

The present translation of Dr. Magnin's work by Dr. Sternberg will be welcome in all English speaking countries, and we trust its circulation may remove much of the ignorance which exists on this subject, among a large class of professional men, who would perhaps be ashamed to confess their want of knowledge.

Among physicians Dr. Magnin's work on the Bacteria should find a wide range of readers; to many it will read like a revelation, and may be the means of developing original ideas, which may give them a fresh impulse in their profession.

It has been a hard struggle with Nature, accompanied by the greatest difficulties, to solve the many problems involved in the phenomena attributed to Bacteria. One hundred and fifty years have passed since Leeuwenhoek, the Father of Microscopy, wrote the first paper on the subject, and Dr. Magnin occupies thirty-one pages of his work in recording a Bibliography of the works of those who have since contributed papers.

By the aid of this large amount of literature treating on Bacteria, supported by his own experience, Dr. Magnin has produced a work, a careful perusal of which will greatly reduce the difficulties of further investigations in solving the many problems still waiting for solution.

A full classification of the genera and species of Bacteria is given, with sufficient descriptions of their forms and characteristics to make their identification an easy task, and although this classification is merely provisional, its practical utility for student's work is not impaired.

We observe ten full-sized plates of engravings, each having from four to twenty-two illustrations of Bacterian forms.

No person possessing a Microscope should be without this book, and it should be closely studied by every physician.

The temptation is great to enter into a description of the varied contents of the work, but the subject is too intricate to be disposed of in a short paragraph and must be reserved for future treatment.

Bacteria are of all beings the most widely diffused; we meet with them everywhere, in the air, in the water, upon the surface of solid bodies, in the interior of plants and animals. They are the cause of disease, and the great agent in putrefaction, and yet the continuance of life on this globe would not be possible without them; they are so minute that some defy measurement with the highest powers of the microscope, but they become a mighty factor in the economy of creation by reason of their wonderful powers of reproduction, for in twenty-four hours the product of a single bacterium by division amounts to sixteen millions of individuals, and at this rate the ocean itself—calculating it equal to two-thirds of the terrestial surface, with a mean depth of one mile, equalling 920,000,000 cubic miles---would be filled with Bacteria in five days from a single germ, supposing the multiplication to be continued with the same conditions.

Fortunately researches of microscopists have brought to light facts regarding these organisms which enable man to control their prodigious reproductive powers, and our knowledge relating to Bacteria will probably at length be acknowledged as one of the greatest victories of modern science.

NOTES.

A PROCESS FOR THE TOTAL DESTRUCTION OF THE ORGANIC MATTERS IN THE DETECTION OF POISONOUS MINERAL SUBSTANCES.—From 100 to 500 grms. of the suspected matter are mixed in a large porcelain capsule with one-fourth its weight of the acid sulphate of potassa, and then with its own weight of fuming nitric acid. The action is very violent at first, and requires afterwards the aid of a slight heat. Here it is proper to stop if it is merely needful to search for arsenic or antimony. A large excess of pure concentrated sulphuric acid (1.845 sp. gr.) is then added, and the mixture is heated to near the boiling point of the acid. More acid is added from time to time till the mixture becomes pale and limpid. To complete the destruction of the last traces of organic matter it is well to let the liquid cool, add a few crystals of pure potassium nitrate, and heat again till abundant white vapors of sulphuric acid are evolved. The saline mass when cold is dissolved in boiling water, made up to 1 litre, and without previous filtration it is submitted to electrolysis by means of 4 Bunsen elements or a Clamond gas-battery. The negative platinum electrode becomes covered with a grey, blackish, or metallic coating. The action should be prolonged for twenty-four hours. If mercury is suspected a plate of gold should be used at the negative pole instead of platinum. If arsenic or antimony is sought for before the addition of the sulphuric acid, the carbonacious mass is cooled, powdered, and treated with boiling water. The solution thus obtained is examined as proposed by Dr. A. Gautier. (*Comptes Rendus*, August, 1875).—A. G. POUCHET.

DETERMINATION OF CARBONIC ACID IN THE AIR.—The authors, after referring to the discordant results obtained in the determination of atmospheric carbonic acid, describe their method. The carbonic acid is fixed by an absorbent body, from which it is afterwards set at liberty and measured by volume. As an absorbent they use pumice stone saturated with solution of potassa, and contained in a tube drawn out at both ends. The tubes are washed with sulphuric acid, filled with small fragments of pumice, calcined with sulphuric acid, and introduced while hot. The pumice is saturated with a given volume of potassa lye, operating in air deprived of carbonic acid. The lye is prepared by dissolving 1 kilo. potassa in 1.400 litres of water, and adding 200 grms. hydrated baryta to remove sulphates and carbonates. The tubes, prepared beforehand and sealed, are opened at the place of operation, and sealed again after 200 litres of air have been passed through.—A. MUNTZ and E. AUBIN.

RESIDUES FROM THE MANUFACTURE OF OILS FROM SCHISTS. The solid residues serve for the manufacture of alum, and may become an important source of lithia. The acid tarry matters contain sulphates of the bases of the pyridic series, especially of corindine, rubidine, and viridine. Aniline is not sensibly present. The insoluble portions and the alkaline tars contain peculiar phenols, thymols β and γ. There is no ordinary phenic acid, and very little thymol a.—GASTON BONG.

SCIENCE:

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